

## **Basic Asset Schedule and Introduction to Problems in Computing Depreciation Expense in Corporate Models Involving Retirements**

In corporate finance models, project finance models and acquisition models a well structured analysis will calculate free cash flow before incorporating financing of assets. There should be a clear distinction between financing and operating analysis consistent with finance theory. The basic free cash flow definition -- EBITDA less working capital changes, less capital expenditures and less operating taxes can guide analysis before financing. Previous discussion covered the modelling of revenues, expenses, capital expenditures and working capital that are all components of the free cash flow calculation. The remaining item necessary to compute free cash flow is the level of operating tax defined as the tax rate multiplied by the EBIT. This is a hypothetical amount of tax that would be paid if the company were financed entirely with equity and had no interest expense, interest income or income from other activities not related to operations. In order to calculate EBIT and derive operating taxes a projection of depreciation expense is necessary. Therefore, calculating the plant assets along with depreciation is the next logical part of the structure of financial models.

Accurately representing depreciation expense in a model is important because tax depreciation effects actual tax payments; because depreciation expense affects taxes used in computing free cash flow; because depreciation expense is used in terminal value calculations where the ratio of capital expenditure to depreciation expense may be used in computing stable ratios; because depreciation expense effects reported earnings; and because the net plant depreciation rate can be used in deriving stable EV/EBITDA ratios. Unfortunately, the calculation of depreciation in a corporate model can be one of the most tricky aspects of the whole process. Much of the discussion in Part 3 of the text associated with stable ratios in a discounted cash flow analysis and computing the implied EV/EBITDA ratio builds from ideas presented in this chapter.

A few difficult programming issues can arise in modelling depreciation expense in the different types of models. The biggest problem is in corporate models related to evaluating the effects of asset retirements that come about because of historic capital expenditures that were made before the start of the forecast period. Further, the retirements for projected capital expenditures must look backward to the time at which the capital expenditures were made. If the depreciation rate is not straight line, the age of each tranche of capital expenditure must be remembered so that one can look-up the appropriate depreciation rate. For a project finance model, the retirement problem for existing assets does not exist because there is no history, but other programming problems arise because the depreciation expense may be a function of the calendar year rather than the annual age of the project. Depending on the tax treatment of a transaction, distinguishing tax depreciation and book depreciation can be difficult and modelling accelerated depreciation can create challenges in acquisition models. Many of these difficult modelling issues can be resolved with a few user defined functions. These functions include:

- Vintage depreciation
- Implied historic capital expenditure pattern from growth rates
- Implied historic growth rates from accumulated depreciation to gross plant

### **Portfolios of Assets with a Vintage Process**

Corporate models may include tax depreciation as well as book depreciation as tax depreciation rather than book depreciation affects true taxes paid and cash flow. If EBIT is computed using book depreciation in the free calculation, then there should be a separate adjustment for changes in deferred taxes derived from calculation of tax depreciation in the calculation. The more correct calculation is:

$$\text{FCFF} = \text{EBITDA} - \text{WC Change} - \text{Capital Expenditure} - \text{EBIT} \times \text{tax rate} + \text{Change in Deferred Tax}$$

Computation of tax depreciation can be complex when the depreciation rate is not constant for each year if accelerated depreciation rates are part of the tax code. To model tax depreciation with accelerated rates and continuing capital expenditures, a matrix with a diagonal pattern is often shown in models as the depreciation expense for an asset depends on its age and information on both the age and the capital expenditure must be retained for the calculation. These fancy looking matrices are sometimes shown for straight line depreciation which is not necessary as the depreciation rate does

not depend on the age of the asset (perhaps modellers want to show how sophisticated they can be). The table below illustrates calculation of accelerated depreciation for assets with an assumed four year life.

Model Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Capital Expenditure	200.00	218.00	237.62	259.01	282.32	307.72	335.42	365.61	398.51	434.38	473.47
	1	2	3	4	5	6	7				
Dep Rate	0.2	0.3	0.2	0.1	0.1	0	0				

Born Yr	Cap Exp	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
2014	200.00	40.00	60.00	40.00	20.00	20.00	-	-	-	-	-	-
2015	218.00	-	43.60	65.40	43.60	21.80	21.80	-	-	-	-	-
2016	237.62	-	-	47.52	71.29	47.52	23.76	23.76	-	-	-	-
2017	259.01	-	-	-	51.80	77.70	51.80	25.90	25.90	-	-	-
2018	282.32	-	-	-	-	56.46	84.69	56.46	28.23	28.23	-	-
2019	307.72	-	-	-	-	-	61.54	92.32	61.54	30.77	30.77	-
2020	335.42	-	-	-	-	-	-	67.08	100.63	67.08	33.54	33.54
2021	365.61	-	-	-	-	-	-	-	73.12	109.68	73.12	36.56
2022	398.51	-	-	-	-	-	-	-	-	79.70	119.55	79.70
2023	434.38	-	-	-	-	-	-	-	-	-	86.88	130.31
2024	473.47	-	-	-	-	-	-	-	-	-	-	94.69
Total		40.00	103.60	152.92	186.69	223.49	243.60	265.53	289.42	315.47	343.87	374.81

To model one of these matrices, the biggest trick is to compute the age of separate assets that are projected to be completed at different times. In the above example, the age of the asset class that goes into service in 2015 is one year old in 2015, while the age of the asset class that went into service in 2014 is two. A square can be created that shows the date the asset is born and the date of the model that allows the age at each vintage to be computed. Once the age of each vintage of plant for each asset class is established, the lookup function can be used with the age as the index to find the appropriate depreciation rate. To make the calculations, the following steps can be used:

- Step 1: Enter the depreciation rate as a function of the age of the plant.
- Step 2: Use the TRANSPOSE function (not the copy and paste special) to set up a matrix that has the year the asset was created on the column and the year of the model on the row. To use the TRANSPOSE function, first shade the target area, then type the function name and finally press SHIFT, CNTL, ENTER instead of simply pressing the enter key. The result called an array variable will include brackets around the result.
- Step 3: Compute the age of the plant through subtracting the model year from the year the asset was born. Allow the age to be negative in years before the asset was created (use relative references by pressing the F4 key multiple times)
- Step 4: Use the LOOKUP function to relate the depreciation rate to the vintage of the plant by applying the age as the lookup index and then shading the age in the depreciation table and then shading the rate.
- Step 5: Multiply the depreciation rate by the cost of the asset being depreciated from the cost of the asset that was created from the TRANSPOSE function and use the IFERROR function (in excel 2007 and later) to avoid problems created by N/A.
- Step 6: Repeat the process for assets with different vintages and with book and tax depreciation.

Instead of this rather long process, you can create your own function with a few lines that accepts capital expenditures and depreciation rates and gives the depreciation expense. You do not show the fancy diagonal matrix, but the modelling is much faster. The function is like the TRANSPOSE function in that the output – period by period depreciation expense -- does not go into one cell, but rather into an array of cells. To create a function that produces a row or column of depreciation expense from an array of capital expenditures and an array of depreciation rates, you need to know a couple of tricks in computing an array function. Three elements in generating an array function include:

1. Define the function as a VARIANT
2. Compute the length of the array by using the .COUNT extension
3. Create an array variable for depreciation expense using the REDIM statement to define the size of the depreciation array

#### 4. Assign an array variable to the name of the function (rather than a single value)

Once you know these things you can create many functions that can make your models far more efficient. The code that produces total depreciation from computing vintages is shown below. After you create it one time you will not have to program the matrix again. Hopefully, this example illustrates the benefits of using functions in excel. You can copy this function into your models or you can create an add in file that contains all of your functions.

```
Function depreciation(capital_expenditure, depreciation_rate) As Variant    ' When the output is an array define as Variant
asset_life = depreciation_rate.Count    ' Find Life from the depreciation rate array
cap_exp_periods = capital_expenditure.Count    ' See how many capital expenditure periods are modelled

ReDim Depreciation_Expense(cap_exp_periods) As Single    ' Make a new array variable that is the output

For model_year = 1 To cap_exp_periods    ' loop around each period
    For vintage = 1 To cap_exp_periods    ' make a second loop to evaluate asset by asset
        age = model_year - vintage + 1    ' calculate the age of each expenditure (the diagonal)

        If (age > 0 And age < asset_life) Then    ' Only when asset is alive
            Depreciation_Expense(model_year) = _
                capital_expenditure(vintage) * depreciation_rate(age) + Depreciation_Expense(model_year)
        End If
    Next vintage    ' Note that the vintage is usef for the capital expenditure
Next model_year

depreciation = Depreciation_Expense

End Function
```

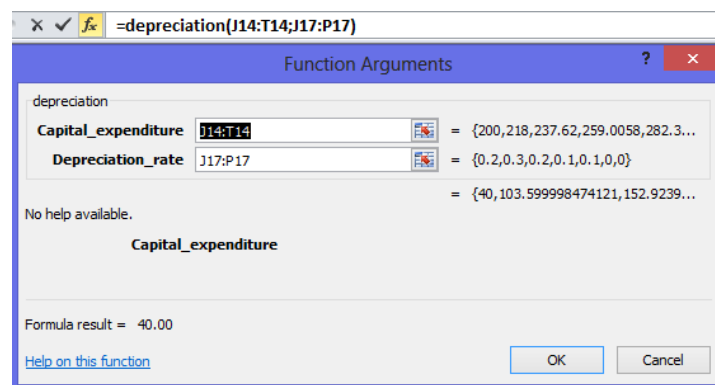
The function that produces an array in the above case only allows you to create the function in a single row. If you would like to output a row as well as a column, the output variable can be defined as a two dimensioned array. An additional loop could then be created that defines the second part of the array as using the same value as the first as illustrated below:

```
ReDim Depreciation_Expense(cap_exp_periods,cap_exp_periods) As Single

For i = 1 To cap_exp_periods
    For j = 1 To cap_exp_periods
        Depreciation_Expense(i,j) = dep(i)
    Next j
Next i

depreciation = Depreciation_Expense
```

To implement a user defined function it is helpful to describe the inputs to the function with descriptive variable names and then use the  $f_x$  thing next to the data entry box. Then you can see the variables required by your function as illustrated below.



This function can also be used in project finance models where the timing of future capital expenditures is variable. In this case, you simply select the entire series of future capital expenditures all of which can be zero except one.

### **The Painful Problem of Coming Up with a Method the Accounts for Asset Retirements in Corporate Models in an Unbiased Manner**

Addressing the problem of asset retirements in corporate models is difficult because information on the plant retirements associated with previously built plant is difficult to obtain as it depends on previous capital expenditures that occurred a long time ago, write-offs, asset sales and revaluations for many historic years. As this information is virtually impossible to obtain, modellers have developed various different methods to solve the problem. Modellers generally firmly believe in their approach and have elegant arguments to support their position. But they cannot really prove their method is accurate. In this section different methods for simulating depreciation and incorporating retirements are addressed.

To measure the benefits and problems of alternative depreciation modelling methods, it is useful to develop a long-term hypothetical model that computes the theoretically correct level of depreciation expense that you can use as the basis of comparison. When developing a theoretical model of the true depreciation expense you should keep in mind the most fundamental aspect of corporate models. That is related to the fact that corporations have a history, an indefinite life and that the model cannot cover all of the periods of the model. A theoretical model that covers the start-up of the firm, a historic period, a modelled period and a long-term stable period can be used to prove which modelling method is accurate in modelling capital assets, retirements, depreciation expense and net plant depreciation rates. The theoretical model that includes different growth rates for each period can produce the true depreciation, the true retirements and the true cash flow for alternative start dates. Once this theoretical base is established alternative methods such as the net plant depreciation method can be tested against the true value. One can evaluate what kind of growth rate assumptions produce big errors and if alternative approaches can be developed.

In developing a theoretical base, one can input different growth rates for different periods (the historic period, the modelled period and the long-term period). The growth rates are used to determine the balance of plant that is required to support the EBITDA (if there is a higher growth rate in EBITDA, a higher growth rate in plant is necessary). The plant balance can then be used to derive the implied level of capital expenditures. This is a bit tricky because the change in plant includes the retirements of plant. The capital expenditures are given by the formula:

$$\text{Change in Plant} = \text{Plant}_1 - \text{Plant}_0 = \text{Capital Expenditures} - \text{Retirements}$$

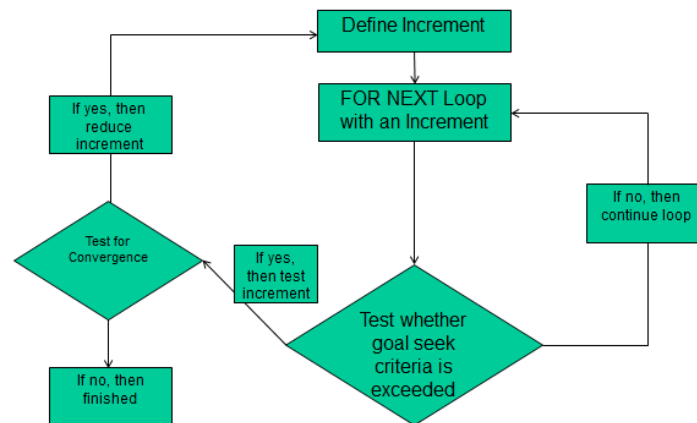
$$\text{Capital Expenditures} = \text{Plant}_1 - \text{Plant}_0 + \text{Retirements}$$

Retirements can be determined by the amount of money spent on capital expenditures in earlier periods. For example if the plant life is five years, then retirements are the amount of capital expenditures that occurred five years ago. When simulating retirements as the lag in capital expenditures, one problem is that retirements cannot be computed until a full life cycle of plant has completed. The first part of a formula for retirements should therefore be an IF statement involving the whether the year is greater than the life of the plant – before this year there are no retirements related to the capital expenditures. When the period is greater than the lifetime, the retirements can be computed. After the first life cycle is complete, retirements should look backward from the current year by the length of the life of the plant. Looking backward can be accomplished using the OFFSET function that begins with a cell and moves up or down and backward or forward:

$$\text{Retirements} = \text{IF}(\text{Year} \geq \text{Asset Life}, \text{OFFSET}(\text{capital expenditure cell}, 0, -\text{Asset Life}))$$

The remaining problem with retirements is that the retirements associated with the initial gross plant must be simulated. To do this one can assume that the historic gross plant was accumulated through making capital expenditures at a constant growth rate. This can be accomplished by deriving the capital expenditures that were made a lifetime ago to sum to the rate. You could compute this amount with a goal seek formula. But this is tedious to put in a model. Instead, you can create a flexible function that does the same thing as the goal seek. The trick to making a function that does the same

thing as a goal seek is to make a FOR NEXT loop that has a small increment. You go around the loop until the goal seek criteria is met. Once you have exceeded the goal seek criteria, you go back and reduce the increment. You do this until the increment is very small and the value is found. The process of making a flexible goal seek that is flexible and changes when you change inputs is illustrated in the diagram below:



The function to create a flexible goal seek formula is shown below. Note that all of the formulas for computing the goal seek must be contained in the function. You cannot create such a function with a big model to do something like find the price to meet a target IRR.

```

'
' This function finds the capital expenditures that were made at the beginning of the life
' It is the automation of a goal seek function
'

Function find_base(growth, life)                                ' Backs into the percentage starting point

min_base = 0                                                    ' Set initial low value for testing
max_base = 1                                                    ' set the cap for testing

new_increment:                                                  ' after exceeded test, come back to this point

    increment = (max_base - min_base) / 10                      ' Re-compute Increment

    For base = min_base To max_base Step increment              ' loop around smaller and smaller increment for base

        plant = base                                            ' Try different values for base
        total_plant = plant                                     ' This is the integral of the plant. You are aiming for 1

        For i = 1 To life - 1                                    ' Go around life to compute the total -- you are aiming for 1.0
            plant = plant * (1 + growth)                        ' Increase the plant by the growth rate
            total_plant = total_plant + plant                    ' Add the plant together (integrate)
        Next i

        If total_plant > 1 Then                                  ' When base is too high go back and try again; if not, continue
            min_base = base - increment                          ' Find a smaller starting point
            max_base = base + increment
            GoTo new_increment
        End If

        If Abs(total_plant - 1) < 0.0000000001 Then              ' Test for convergence
            find_base = base
            Exit Function
        End If

    Next base                                                    ' Loop over base

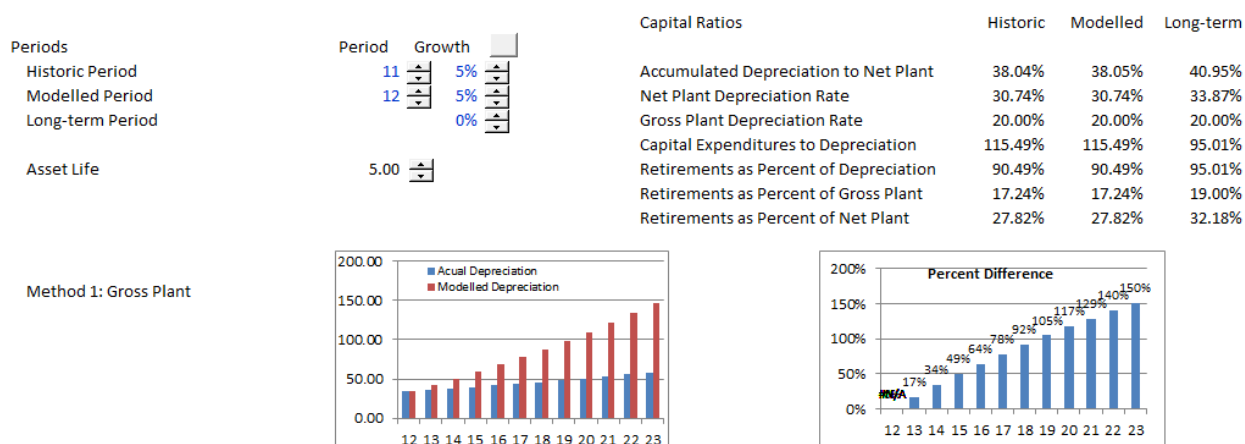
End Function

```

## Alternative Methods for Deriving Retirements Associated with Existing Assets in a Corporate Model

For a single asset with no terminal value, straight line depreciation is simply the gross amount spent on an asset divided by the plant life. Given this fact, one approach to computing depreciation expense

is to keep track of the balance of the gross plant (i.e. without deductions for accumulated depreciation) from a table beginning with existing plant and adding capital expenditures. As explained earlier, the gross plant can be set to actual gross plant during the historic period and computed as the opening balance plus the capital expenditures in the projection period using a historic switch. Gross plant balance can then be multiplied by the depreciation rate to establish projected depreciation. The problem with this method is that it does not account for any retirements associated with existing plant. By ignoring retirements, the method overstates depreciation expense and it can lead to underestimation of taxes. Cash flow is overstated because gross plant never declines as assets are retired. The problem is worse when the asset life is short and when the growth rate is slow. When the asset life is short, there should be a lot of retirements on exiting plant that are ignored and when the growth rate is slow, the retirements approach 100% of depreciation. The excerpt below demonstrates that when the growth rate is 5% and the asset life is 5 years, the overstatement of depreciation approaches 100% after a few years. The comparison between modelled depreciation and true depreciation is derived from the theoretical computation of depreciation discussed in the prior section.

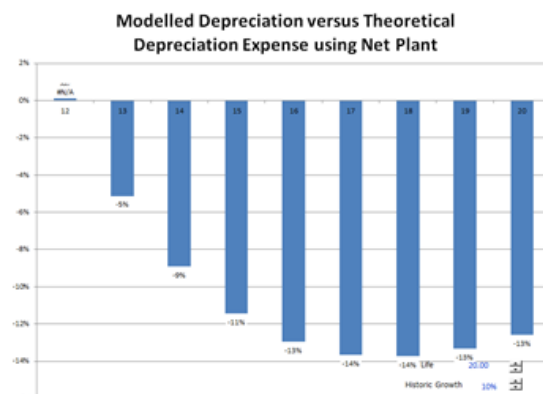
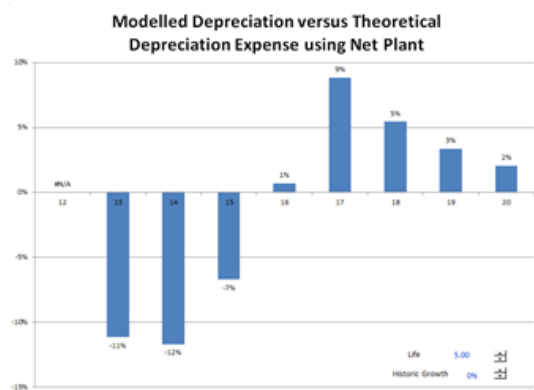


A second approach sometimes used is to separate the depreciation on existing assets from the depreciation on new assets. A separate schedule for the depreciation on new assets is computed using the vintage method described above. The depreciation on existing assets can either simply continue the existing level of depreciation or decline to account for retirements. The existing depreciation should also account for the capital expenditures made in the final historic year. If the existing level of depreciation does not reflect retirements and the lifetime of new assets is fairly long, the method is not very different than the above method. In this case there are no retirements of new assets or existing assets in the analysis and the depreciation is overstated. If retirements on existing assets are accounted for, some kind of retirement statistic must be entered and then the accumulated retirements should be calculated. Once the accumulated retirements are tabulated, the adjustment to existing depreciation can be computed as the accumulated amount multiplied by a depreciation rate. Further, a MIN test should be included so that the depreciation on the retirements do not exceed the existing depreciation expense. This approach to depreciation expense is illustrated in the excerpt below. When these adjustments are made, the depreciation expense is more accurate. The problem with this method is that it is a bit tedious to implement and one needs information on historic growth and the retirements as a percent of depreciation expense.

Period	Test	Growth	0	10	11	12	13	14	15	16	17	18
Historic Period	11	5%		TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Modelled Period	9	5%		FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Long-term Period	280	0%		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Test	TRUE			TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Simulated Depreciation Method TWO - Existing Depreciation Flat and New Depreciation												
Existing Depreciation				0.00	34.21	34.21	34.21	34.21	34.21	34.21	34.21	34.21
Retirements to Depreciation				0.00	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Retirements				0.00	30.95	30.95	30.95	30.95	30.95	30.95	30.95	30.95
Accumulated Retirements				FALSE	FALSE	30.95	61.91	92.86	123.81	154.76	185.72	216.67
Depreciation on Retirements				0.00	0.00	0.00	6.19	12.38	18.57	24.76	30.95	34.21
New Plant Balance												
Opening Balance				0.00	0.00	0.00	39.50	80.98	124.54	170.27	218.29	229.20
Add: Capital Expenditures				FALSE	FALSE	39.50	41.48	43.55	45.73	48.02	50.42	52.94
Less: Retirements				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	39.50	41.48
Closing Balance				0.00	0.00	39.50	80.98	124.54	170.27	218.29	229.20	240.66
Depreciation Rate				0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Depreciation Expense				0.00	0.00	0.00	7.90	16.20	24.91	34.05	43.66	45.84
Total Modelled Depreciation				0.00	34.21	34.21	35.92	38.02	40.54	43.50	46.91	45.84

To approximate retirements, some modellers project depreciation on existing assets using the net plant balance multiplied by the net plant depreciation rate and separately compute the depreciation on new assets. As the balance of net plant declines each period, the depreciation expense also declines implying that retirement of assets for existing assets is implicitly reflected in the forecast. If this net plant method is used, one must make sure that the net plant balance does not become negative. Although this approach of splitting-up depreciation does indirectly account for retirements, it is not an accurate reflection of retirements unless the rate of retirement for existing assets (relative to net plant) is the same as the net plant depreciation rate. The approach assumes that if the net plant depreciation rate is 15%, then the implicit retirement rate percentage of existing assets is also 15%. Unless the growth rate for the historic period is zero, there is no basis for making this assumption. Another problem with this approach is that, the depreciation rate on net plant does not remain constant over the lifetime of existing assets. If the retirements are less than depreciation, then the depreciation rate on net plant will increase as the net plant balance declines. Over the lifetime of a single asset, the ratio of depreciation expense to net plant – the gross plant less the accumulated depreciation expense – declines as depreciation remains constant but net plant reduces. For a company or project with many assets, multiplying net plant by a constant depreciation rate can also result in biased forecasts because the depreciation rate on net plant is affected by the growth rate of the company and when growth rate changes, the depreciation rate on net plant also changes.

The pattern of errors from applying the net plant method is illustrated below for cases with different growth and different plant lives. The left panel demonstrates the method understates depreciation in early years, but overstates depreciation in later years with a short life and a low growth rate. The right panel shows the depreciation is consistently understated using the second method. Where depreciation is understated, the cash flow is understated and the income is overstated. If you are using the formula  $\text{NOPLAT} \times (1-g/\text{ROIC})/(\text{WACC}-g)$  then the understatement in depreciation results in an understatement of terminal value. Finally, note that the error in computing depreciation is less using the net plant method than the error from ignoring retirements.



The third method introduced is to directly model the retirements using the historic growth rate and to separately model the new assets using a vintage approach. Application of this method requires two user defined functions and computing retirements associated with the existing assets. With the two functions and information regularly reported on the financial statements you quickly make the more accurate calculation. To make a more accurate calculation of depreciation on existing assets from the theoretical retirements you can follow the following step by step process:

Step 1: Find the ratio of the accumulated depreciation to net plant from the historic financials

Step 2: Compute the **implied historic growth** from the accumulated depreciation to net plant by making a user defined function. This function is similar to the function discussed above to find the base level of retirements. If is a function that does the same thing as a goal seek on a dynamic basis. You start with a loop from -100% growth to 100% growth and step around by 1%. Then you compute the ratio of accumulated depreciation to plant. Once the target ratio has been found, you make a smaller increment than 1% and make another loop. You repeat the process until the computed ratio of accumulated depreciation to plant just equals your target level.

Step 3: Compute the **base retirements** as a percent of gross plant by using the base retirement function defined above. Recall that this function accepts the growth rate and the plant life, both of which have now been determined.

Step 4: Compute retirements of the existing plant over the projected period. This can be accomplished by making a switch for the first modelled period. In this period the retirements are the opening plant balance multiplied by the base retirements established above. For subsequent periods, the retirements are the prior value of retirements multiplied by the growth rate computed in step 2. The formula for retirements is:

$$\text{Existing Retirements} = \text{IF}(\text{First Modelled Period}, \text{Opening Gross Plant} \times \text{Base}, \text{Prior Value} \times (1 + \text{Growth}))$$

Step 5: Compute the balance of plant, the depreciation on existing plant and the depreciation on new plant.

An example of this process for computing the depreciation is demonstrated below.



Period	Test	Growth	0	15	16	17	18	19	20	21	22	23	24
Historic Period	16	7%		TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Modelled Period	17	10%		FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Long-term Period	267	10%		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Test	TRUE			TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Parameters													
Life	6.00												
Accumulated Depreciation From History	38.39%												
Implied Historic Growth	6.99%												
Base Retirements	13.98%												
Existing Deprecation													
Opening Balance				257.85	275.90	295.22	253.94	209.77	162.52	111.96	57.87	0.00	0.00
Less: Retirements				0.00	0.00	41.28	44.16	47.25	50.56	54.09	57.87	0.00	0.00
Closing Balance				275.90	295.22	253.94	209.77	162.52	111.96	57.87	0.00	0.00	0.00
Deprecation on Existing Plant				0.00	0.00	49.20	42.32	34.96	27.09	18.66	9.65	0.00	0.00
New Depreciation													
Opening Balance				0.00	0.00	0.00	70.79	147.42	230.40	320.25	417.57	522.99	575.29
Add: New Capial Expenditures				FALSE	FALSE	70.79	76.63	82.97	89.85	97.32	105.43	123.09	134.16
Less: Retirements on New Plant				FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	70.79	76.63
Closing Balance				0.00	0.00	70.79	147.42	230.40	320.25	417.57	522.99	575.29	632.82
Deprecation on New Plant				0.00	0.00	0.00	11.80	24.57	38.40	53.37	69.59	87.17	95.88
Total Modelled Depreciation				0.00	0.00	49.20	54.12	59.53	65.49	72.04	79.24	87.17	95.88
Theoretical Depreciation				42.98	45.98	49.20	54.12	59.54	65.49	72.04	79.24	87.17	95.88

If the historic growth rate is not constant, computing the implied growth from the accumulated depreciation ratio may not be precise and assuming the retirements follow a constant growth rate will not be perfect. However, an experiment with random growth demonstrates that the error is very small.

## Depreciation Issues in Project Finance Models

In a project finance model, depreciation should be computed through establishing a gross plant balance account which increases with the construction costs over the construction period. To begin the depreciation at commencement of operation, the tax depreciation rate (which may vary with the age of the project) is multiplied by the balance of the plant as well as operating switch. As with the non-project finance models, the accumulated depreciation should be computed after the depreciation expense row. Computing depreciation can be complicated in a project finance model because of the manner in which tax depreciation is driven by the calendar year rather than the date the project begins operation. If the operation date is 27 December, the depreciation is the same as if the operation date is 5 January meaning it is much better to put the plant in service at the end of the calendar year. To resolve this problem, the number of calendar months in the year should be computed and the calendar year must be computed. Some techniques to accomplish this include:

1. Compute a switch for a new calendar year by making a test when the month of the start date is greater than the month of the end date using the MONTH function.
2. Use the switch to make a counter for the calendar year through accumulating the switch
3. Make an adjustment for the first operating year for which the counter should begin (you have to also make an adjustment so that you do not double count).
4. Use the COUNTIF function using both the range and the criteria as the annual year to find the number of periods per year.
5. The depreciation rate for the period is 1/life divided by the periods per year.

## Adjusting the Tax Basis in an Acquisition

For tax purposes, an acquisition can be treated as a purchase of assets or a purchase of shares of stock. This tax treatment must be distinguished from the book accounting for an acquisition which results in re-valuation of assets and re-establishing the equity. If the acquisition involves a purchase of assets of assets rather than the purchase of stock for tax purposes, the acquisition price should be have a higher value as the asset base will be higher and the value of depreciation deductions increase. In evaluating an acquisition, comparative multiples should account for the difference in value from purchase of stock versus purchase of assets as the multiples should account for the difference in tax rates for different countries.

If the acquisition is a stock transaction, no write-up for tax purposes occurs, the seller does not pay tax on gain realized from selling asset and the buyer can use the existing net operating loss. For an asset purchase the tax depreciation deductions take place over an extended period while the taxable gain must be paid immediately by the seller. Therefore, from the perspective of both the acquiring company and the target company on a combined basis, a stock transaction generally has a positive outcome because the gain on the sale is taxable as current income while the write-up is deducted on a periodic basis. On a present value basis, the government treasury wins and the combined shareholders of the two companies lose if the transaction is classified as an asset purchase. In situations with net operating loss, the situation is even worse as the value of the net operating loss carry-forward is lost.

To establish the tax and book depreciation expense in alternative transaction structures, the following steps can facilitate the development of a model:

1. The existing deferred taxes can be used to derive the existing difference between the tax and book base through dividing the accumulated deferred tax related to depreciation by the income tax rate.

$$\text{Existing Basis Difference} = \text{Accumulated Deferred Tax} / \text{Income Tax Rate}$$

2. In a stock transaction, the valuation of the assets increases for books, but the tax basis does not change. The difference in the basis increases the balance of accumulated deferred tax as demonstrated in the formula below.

$$\begin{aligned} \text{Accumulated Deferred Tax after Transaction} = \\ (\text{New Book Basis} - \text{Existing Basis}) \times \text{Income Tax Rate} \end{aligned}$$

3. When computing the goodwill for developing the pro-forma balance sheet, the increase in assets as well as the increase of accumulated deferred tax must be accounted for. In addition to other goodwill adjustments, the goodwill formula should include:

$$\text{Goodwill} = \text{Goodwill} - \text{Increase in Asset Valuation} - \text{Increase in Accumulated Deferred Tax}$$